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Validation of gyrokinetic simulations in NSTX including comparisons with a synthetic diagnostic for high-k scattering.

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A new extensive validation study performed for a modest beta NSTX NBI-heated H-mode predicts that electron thermal transport can be entirely explained by short-wavelength electron-scale turbulence fluctuations driven by the electron temperature gradient mode (ETG), both in conditions of strong and weak ETG turbulence drive. For the first time, local, nonlinear gyrokinetic simulations carried out with the GYRO code [Candy JPP 2003] reproduce the experimental levels of electron thermal transport while simultaneously matching the frequency spectrum of electron-scale turbulence, the shape of the wavenumber spectrum and the ratio of fluctuation levels between strongly driven and weakly driven ETG turbulence conditions. Ion thermal transport is shown to be very close to neoclassical levels predicted by NEO [Belli PPCF 2008], consistent with stable ion-scale turbulence predicted by GYRO. Comparisons between high-k fluctuation measurements [Smith RSI 2008] and simulations are enabled via a novel synthetic high-k diagnostic developed for GYRO. The frequency spectra characteristics of electron-scale turbulence (spectral peak and width) can be reproduced by the synthetic spectra, but prove not to be critical constraints on the simulations. However, the shape of the high-k wavenumber spectrum and the fluctuation level ratio between the strong and weak ETG conditions can also be simultaneously matched by electron-scale simulations within sensitivity scans about the experimental profile values, and prove to be great discriminators of the simulations analyzed. Electron-scale simulations were also able to isolate the effect of safety factor and magnetic shear to match the shape of the measured fluctuation wavenumber spectrum. This work is the strongest experimental evidence to date that ETG-driven turbulence can dominate in the outer-core of modest beta NSTX H-modes.

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